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**PRELIMINARY REPORT
GROUND WATER AVAILABILITY STUDY
SEBASTOPOL, CALIFORNIA**

Preliminary report ground
water availability study
1991.

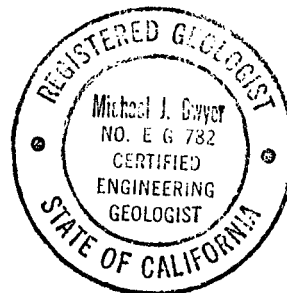
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February 10, 1991

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PRELIMINARY REPORT GROUND WATER AVAILABILITY STUDY SEBASTOPOL, CALIFORNIA FOR THE CITY OF SEBASTOPOL

INTRODUCTION

This report presents preliminary findings, conclusions and recommendations regarding the feasibility of developing additional ground water resources for the City of Sebastopol. The data collection, analysis and most of the summary of findings contained in this report were prepared by Michael S. Malone, Certified Engineering Geologist of Geotrend, Inc. Our services were provided according to the contents of our proposals to the City of Sebastopol dated June 23 and November 2, 1990.

It is our understanding that the City of Sebastopol is interested in evaluating the feasibility of installing an additional municipal well(s) to be located in the general vicinity of the Laguna de Santa Rosa and Gravenstein Highway. In this regard we have performed a preliminary evaluation of the general geologic and hydrogeologic conditions in this general area to assess the feasibility of the proposed well development. Initially, we met with Jim Mitchell, Mitchell & Heryford, Consulting Engineers and Land Surveyors, to discuss the project and to define the study area. Following completion of work, the City of Sebastopol requested us to provide supplemental services in November, 1990 for the purpose of evaluating additional, more representative ground water level data. This report contains the results of both the earlier and supplemental work by us.

Our scope of services consisted of the following work elements:

1. Obtained and reviewed selected water well logs, published geologic and hydrogeologic literature pertinent to the study area and vicinity.

2. Met with personnel of the Sebastopol Department of Public Works to review selected files regarding well pumping and well performance histories.
3. Prepared graphics¹ (tables, figures, and plates) based on existing geologic and ground water data.
4. Prepared this report containing our findings, preliminary conclusions and recommendations.

While comment is occasionally made in this report regarding ground water contamination, it is made for background purposes only. The principle purpose of this report is to evaluate, in a preliminary manner, the ground water availability within the study area, and not to assess reported contamination conditions.

PREVIOUS STUDIES AND DATA SOURCES

Several studies of the ground water conditions in the Santa Rosa Plain and Sebastopol area have been performed by the California Department of Water Resources (DWR), 1975, 1982 and U. S. Geological Survey, 1958, 1987. These are listed in the Reference/Bibliography section.

A study was performed by M. C. Yoder Associates in 1967 for the City of Sebastopol titled "Water Supply and Distribution". In this study it was concluded that the prospects for future development in the area were good, based on the performance of existing wells from 500 to 700 feet deep; and it was judged that potentially favorable aquifer characteristics were possibly present as deep as 1,000 feet. At that time, Sebastopol had three operating wells: Numbers 2, 4, and 5. Further, the Yoder report recommended a detailed study be performed to determine the amount of water which could be removed from the well field without adversely affecting the natural recharge capabilities of the area. Data compiled by DWR since Yoder's report provides considerable information in this regard.

1. For cost savings purposes, most of the graphics (Plates 2, 3 and 4) have been prepared in draft form only and have been submitted under separate cover.

In addition to previous published reports, our evaluation utilized data obtained from well drillers' logs², as well as data on file with the City of Sebastopol Public Works Department, and the Sonoma County Water Agency.

It is to be noted that the data obtained from the files of the City of Sebastopol, Department of Public Works is approximate in nature. Although it is our opinion the data provides reasonable basis for preliminary characterization of City well performance and aquifer conditions, the data should not be solely utilized for final well site selection and well design.

SITE CONDITIONS

GENERAL DESCRIPTION

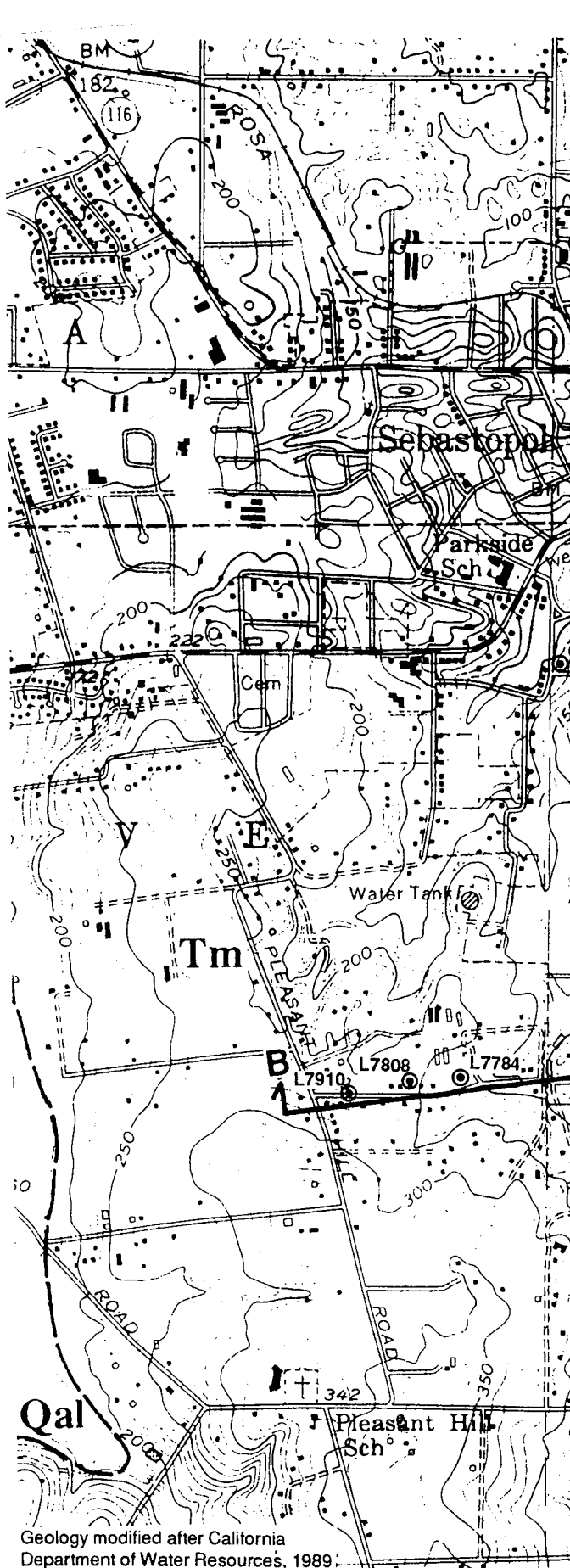
Sebastopol is situated along the western margin of the Santa Rosa Plain at elevations ranging from approximately 70 to 200 feet above sea level. Much of the town is located in the low hills west of the plain with portions extending eastward into the low lying areas adjacent to the Laguna de Santa Rosa. Surface drainage from the hills flows easterly into the northwest flowing drainage of the Laguna de Santa Rosa.

West of town the hills extend up to elevations of about 350 feet. This area is utilized principally for fruit growing and low density residential development. Abundant domestic and irrigation wells are present throughout this area. These wells typically extend to depths of about 150 to 250 feet with some as deep as 450 feet.

CITY WELLS

Sebastopol currently utilizes three wells for its municipal water supply; Numbers 2, 4 and 6. Refer to Plate 1, Project Location and Geology Map. Wells 6 and 4 are located near Gravenstein Highway South in the relatively low lying areas along the City's eastern margin, and Well 2 is near a small north flowing drainage at the intersection of Jewell and Calder Avenues. A fourth well, Number 5 located north of Well 4 near Fannon and Eleanor Streets, was utilized until 1986 but has since been shut down due to contamination problems. Well 2 is beyond our study area and is not discussed further in this report.

2. Water Well Drillers' reports on file at the California Department of Water Resources, Sacramento, and some local agencies.



ION

on Locations
lates 2 and 3)

for Cross Section Preparation
city well location
L signify private well locations

as with potential for the siting
municipal water wells (See text of report)

TA ROSA AREA

OSITS - dark clay and silty clay, rich
tuff; low specific yield (3-7%)

- sand, silt, clay, and gravel; variable
(3-15%)

FAN DEPOSITS - fine sand, silt, silty clay, coarse sand
with gravel more abundant near heads of fans;
high specific yield (8-17%)

N FORMATION - gravel, sand, silt, local interbedded tuff;
yield (3-7%)

OLCANICS - volcanic flows, agglomerates, and tuffs;
apparent specific yield (0-15%)

ORMATION* - coarse-to fine-grained sandstone with minor
clay; high specific yield (10-20%)

FORMATION - clay and shale with minor amounts
; low specific yield (3-7%)

OLCANICS - volcanic flows, tuffs, breccias, and agglomerates;
arent specific yield (0-10%)

AN COMPLEX - sandstone, shale, greenstone, chert, and
very low specific yield (<3%)

is the Wilson Grove Formation

***??.?

FAULT

dashed where approximately located
dotted where concealed
arrow indicates direction of dip

x : indicates potentially active
? : questionable

ATE 1

PROJECT LOCATION AND GEOLOGY MAP

SEBASTOPOL GROUNDWATER AVAILABILITY REPORT
SEBASTOPOL, CALIFORNIA

Geology modified after California
Department of Water Resources, 1989

Pump rates presented in this report for City operated wells have been normalized to reflect the equivalent of sustained pumping conditions over a continuous 24 hour period. This has been done because the City wells are pumped at variable rates for different time periods depending on daily water demands. Use of the variable rates would not allow an easy comparison between wells. Thus, the rates have been recalculated, or normalized, to reflect the equivalent of sustained pump rates over the 24 hour period.

GEOLOGY

The Sebastopol area is underlain by the Wilson Grove formation, (previously known as the Merced formation). The Wilson Grove formation is composed predominantly of poorly cemented, loose sandstone with zones of shell, gravel and mostly minor clay. Harder, more cemented, presumably less permeable, varieties of sandstone are also present. The general lack of detailed water well logs and down-hole geophysical logs make identification of specific strata within the formation difficult, and as a consequence, projection of subsurface strata between wells is conjectural. The composition of the Wilson Grove formation is relatively uniform. However, well log data compiled for this study suggests three general groups of material may be present in the vicinity of City Wells 4, 5, and 6 - refer to Draft Plates 2 and 3, Preliminary Geologic Cross Sections. These are an uppermost unconsolidated sand and gravel of about 120 feet in thickness, generally lacking in shells; an intermediate unit comprised of sandstone and sandy clay with frequent shells and minor gravel; and a lowermost sand unit generally lacking in shells. The lowermost unit was penetrated in City Well 6 and partially in Wells 4 and 5. However, the wells were only completed (installation of casing, screens, gravel packing, etc.) to depths of about 550 feet. Conversations with local well drillers (Weeks Drilling Co., 1990) suggest that the lowermost unit was not developed in Well 6 due to the presence of clay and the increasingly cemented nature of the sandstone. The evaluation of geophysical logs (available only for Well 6) indicate a general decrease in resistivity with increasing spontaneous potential. This suggests either increasing clay content and/or slightly increasing salinity of pore water at depths below approximately 500 feet. The top of the uppermost unit probably includes loose to poorly lithified Quaternary (geologically young) alluvial deposits, judging from its soil-like consistency and general absence of shells.

**PRELIMINARY REPORT
CITY OF SEBASTOPOL
February 10, 1991**

Estimates of the thickness of the Wilson Grove formation range from 500 feet to 2,000 feet, with apparent gradual thinning toward the south (refer to Draft Plate 2, Preliminary Geologic Cross Section). Folding is generally absent in the study area and bedding dips gently toward the east (refer to Draft Plate 3, Preliminary Geologic Cross Section). The Sebastopol fault, whose existence is suggested by DWR (1982), is interpreted by them to be a near-vertical northwest striking fault located immediately east of Sebastopol in the vicinity of the Laguna de Santa Rosa. This fault may offset the Wilson Grove formation several tens of feet. In the Sebastopol area, or slightly to the east, the Wilson Grove formation is underlain by the more clay and shale-rich Petaluma formation (DWR, 1982). At greater depths, the basement rocks of the geologically much older Franciscan Assemblage underlie both of these formations.

Several feet of surficial soils composed of clayey and sandy topsoil blanket much of the project area and vicinity. Recent alluvium is present in the larger drainages, and clayey basin deposits are present in the low lying areas of the Santa Rosa Plain.

HYDROGEOLOGY

The Wilson Grove formation is the principle water bearing unit in the Sebastopol area and historically it has been a major source of ground water for irrigation, domestic and municipal purposes. The general absence of continuous impermeable strata, such as clay, indicates the ground water occurs in primarily an unconfined (water table) condition. However, reports (our review of driller's logs) of several flowing (artesian) wells in the Bloomfield Road area south of Sebastopol indicate that locally confined conditions may exist. Drillers' logs indicate that static ground water levels are typically less than 50 feet below the ground surface in the area of Gravenstein Highway and somewhat deeper in the elevated areas to the west. However, well withdrawals have likely contributed to localized lowering of the water table. City Well 4, developed to a depth of 508 feet and pumped at between 220 to 425 gallons per minute per 24 hours based on the July 1989 to October 1990 period has exhibited virtually no significant water level decline since 1985, indicative of the considerable amount of water available from the Wilson Grove formation in this area.

The area west and southwest of Sebastopol has been identified by DWR as an area of ground water recharge. Recharge is primarily due to infiltration of precipitation and stream

flow. DWR interpreted that the general movement of ground water in 1975 was from the elevated area west of Sebastopol eastward toward the Laguna de Santa Rosa. Data presented by DWR in 1987 regarding the ground water changes in the Santa Rosa Plain indicate that the ground water levels just east of Sebastopol rose from April 1978 to April 1984. This suggests that recharge of ground water is occurring in the western portion of the Santa Rosa Plain adjacent to Sebastopol perhaps as a result of decreasing use of ground water or recharge resulting from the unusually wet winter of 1981-1982. DWR reported in their 1982 study that ground water in the low lying areas adjacent to the Laguna de Santa Rosa and south of town near Bloomfield Road were fully recharged (Sections 1 and 12 of the Sebastopol Quadrangle - refer to Plate 1). The area including Sebastopol and the low hills to the southwest of town (Sections 2 and 11) were about 7% to 17% less than fully recharged in the spring of 1980. It should be noted that water table elevations and ground water flow can be modified as a result of seasonal variation of precipitation and withdrawal or injection of water by wells. Drawdown in wells can also result in increased recharge from infiltration of water from surface sources including ponds, streams and other bodies of water.

Several pump tests were conducted by DWR and the Sonoma County Water Agency to estimate the effect of the Sebastopol fault on ground water flow. This fault was suspected of being a barrier to ground water flow. However, the pump tests were inconclusive in this regard, and our literature review suggests that the presence of this fault has not been conclusively established.

PERFORMANCE OF CITY WELLS 4, 5, AND 6

Preliminary evaluation of water levels recorded at City Wells 4, 5, and 6 from 1985 to November 1990 provide general information about the performance and capacity of the aquifer (Wilson Grove formation) in the area along Gravenstein Highway. The wells are intermittently pumped by the City on a daily basis, and levels have been intermittently recorded by the City both during pumping cycles and after pumping has been discontinued. These measurements are presented on Draft Plate 4, Preliminary Hydrograph. To obtain reliable measurement of static water level, a well should be shut off sufficiently long to allow the cone of depression created around it, due to withdrawal, to be fully recharged and stabilized. Normally, this would be expected to take considerably longer than the few hours a well is shut down during its daily pump cycle. However, based on a comparison

of the water levels recorded at Well 5 before it was shut off in 1986 with the static levels recorded since (see Draft Plate 3), it appears that the highest and lowest levels recorded while the pump was in service provide a reasonable approximation of static water levels and possible minimum levels due to drawdown. Thus, despite limitations, past water levels recorded at the subject City wells can provide a preliminary basis for evaluating the condition of the aquifer adjacent to the wells, and the effects of the well on the aquifer. These levels are important for making estimates of well performance and aquifer characteristics.

Well 5 is the northern of the three City wells in the Gravenstein Highway-Laguna de Santa Rosa area. Comparison of water levels recorded at Well 5 before it was shut off in 1986 with levels recorded after discontinuation of use indicate that the water levels recorded while the well was in service provide a reasonable approximation of long term static water levels. That is, after pumping ceased at Well 5 in 1986 water levels rose to the long term static condition. Levels observed while the well was in service prior to 1986 were nearly the same as those long term levels, suggesting that recovery of ground water to the long term static levels occurred within the relatively short time interval between daily pumping cycles. The relatively rapid recovery of the water levels to the static condition while the well was being used suggests that the pumped volumes were not exceeding the aquifer capacity and that the ground water resource near Well 5 fully recovered soon after pumping ceased.

Well 4 is located between Well 5 and 6, and is approximately 1,600 feet south of Well 5 and 2,100 feet north of Well 6. The long term static water level at this well is reported to be 37 feet (Schock, 1988). As summarized on Plate 4, observed high water levels from the period of January 1985 through June 1990, while the well was in service, were typically 60 to 80 feet deep and low levels were typically near 100 feet. From this data, it appears that full recovery of the aquifer does not occur while the pump is in use. However, water levels appear to have stabilized at those lower depths in response to the well's historic pumping volumes. Examination of pump records available from the City files for 1989 through March 1990 indicate pump use for that period ranged from a low of 6.1 hours per day to a high of 13.4 hours per day at an approximate pump rate of 840 gpm. To compare with other wells, the flow rates are normalized to a 24 hour pump period, resulting in flow rates ranging from approximately 220 gpm during the winter months to 425 gpm during the peak demand months of summer.

Well 6 is the southernmost of the City's wells. The water level observed in Well 6 when it was drilled in 1968 was 39 feet. Water levels observed since 1986 indicate a gradual decline with levels falling from average high readings of approximately 130 feet in 1987 to 150 feet in 1989. Records in July 1989 mention water levels below 150 feet and a single reading in July 1990 recorded at 158 feet. Well screens in Well 6 are at a depth of 172 feet and that depth is considered the maximum level to which the drawdown be taken. To better evaluate the current water level conditions, water levels were obtained in mid-November, 1990, by Public Works personnel as part of this study. Levels were recorded before and after six and eight hour pump periods with and intervening 16 hour period of no pumping. Pumping was performed at a rate of 1,000 gpm to approximate a typical pump cycle for this well. Minimum water levels of 125 and 127 feet were recorded for the six and eight hour pump periods, respectively, with water levels recovering to 97 feet during the 16 hour interval. These observations indicate that under current use the water levels in Well 6 are adequate. Pumping rates significantly higher than 1,000 gpm have been employed at Well 6 in the past (up to 1,600 gpm) and these high pump rates may account for the periodically low levels recorded there.

To compare the aquifer performance at Wells 4 and 6, data presented by Schock (June, 1988) was used to calculate the specific capacities of these two wells. (Specific capacity is an estimate of an aquifer's water yielding capacity and is calculated by dividing the pump rate in gpm by the drawdown in feet.) These values indicate that the aquifer is performing similarly at these wells.

Table 1: SEBASTOPOL CITY WELL DATA *

Well No.	Well Depth (feet)	Screened Interval (depth)	Static Water Level (depth)	Pumping Water Level (depth)	Discharge (gpm/24hr)	Specific Capacity (gpm/ft)
4	530	237-468	37	76	563	14.4
5	528	138-528	42 (1990)	NA	NA	NA
6	572	172-552	53	140	1,067	12.2

* Source: Schock, June 9, 1988, Well Data to Department of Health Services - data summarized from City of Sebastopol files.

By comparing the Well 4 and Well 6 hydrographs (Draft Plate 4), it is apparent that water levels at Well 4 have remained virtually unchanged since 1985, indicating that historic pumping rates (normalized to 24 hour duration) ranging from approximately 220 gpm to 425 gpm are not adversely overdrawing the aquifer. By comparison, water levels at Well 6 are somewhat lower than at Well 4, and have apparently experienced a gradual decline since 1987, with occasionally short term drops to levels close to 160 feet. The lower water levels and gradual decline at Well 6 may be the result of withdrawals slightly in excess of the aquifer capacity with the occasional large drops due to short periods of very high pump rates (up to 1,600 gpm). Complicating this interpretation is the unknown effects of active private wells located near Well 6 and the possibility that precipitation patterns are affecting overall water levels near Well 6.

The interaction of Wells 4, 5 and 6 with one another is important as a means of estimating the possible interference effects of new wells placed into the existing well field. If Well 5 had been interfering with Well 4, it would be expected that Well 4 would have shown a general increase in its water level after Well 5 was shut down. No distinct increase in Well 4 levels are apparent on the hydrograph (Plate 4) when Well 5 was shut down, indicating an absence of interference between these two wells. Wells 4 and 6 are approximately 2,100 feet apart and the general decline of Well 6 water levels since 1985 does not appear to be occurring at Well 4. However, the highest water levels recorded at Well 4 are lower than the static levels reported during initial well drilling. This difference may be due to an insufficient period of time between pump cycles at Well 4 to allow complete recovery to static levels. The gradual decline at Well 6 since 1987 could be explained by overdraft of the aquifer due to excessive withdrawals, a general lowering of the water table due to precipitation patterns, and/or interference effects from nearby private wells.

CONCLUSIONS AND RECOMMENDATIONS

The ground water resource in the low lying areas adjacent to Gravenstein Highway South appears adequate to support additional municipal supply wells. General areas with potential for the siting of future municipal water wells are shown on Plate 1. It is possible these areas can be considerably expanded depending on the results of future work as described below.

Approximately the upper 500 to 600 feet of the Wilson Grove Formation has been utilized in the past for water supply. Some limited potential may exist at greater depths. However, the availability of ground water below that depth is somewhat uncertain due to a lack of sufficient geophysical, pump test and geologic data. The geophysical log performed for Well 6 indicates diminishing ground water availability below a depth of approximately 500 feet. The geologic cross sections (Plates 2 and 3) indicate a slight thinning of the water bearing zone toward the south and deepening toward the east.

Sustainable discharges similar to Wells 4 and 5 (approximately 200 to 400 gpm/24 hours) are expectable from new wells, provided sufficient separation is maintained from existing wells and ground water barriers.

Appropriate well spacing depends on a number of factors including the withdrawal rates, well depth, and the lateral extent of drawdown (interference) from existing and planned wells. The performance of the existing municipal Wells 4, 5, and 6 indicates that a well spacing of 1,600 to 2,100 feet is probably adequate between wells producing 200 to 400 gpm/24 hours. Closer spacing may be feasible. However, that determination should be based on future pump tests conducted at existing City wells, and by evaluating existing private wells adjacent to candidate well sites.

The Sebastopol fault is a suspected barrier to ground water flow. Although its role as a barrier is unproven, we believe it prudent to locate new wells at least 1,000 feet from this fault to minimize possible interference effects.

Preliminary water level data suggests that Well 6 may have intermittently approached its maximum available drawdown (water levels in June 1990 were only 12 feet above the well screen). This may be the result of a general decline in the aquifer due to excessive withdrawals coupled with short periods of high pump rates during summer months when demand is highest, and/or possibly interference from private wells. Also, one cannot rule out the possibility of nonrepresentative water level data due to the intermittent nature of its acquisition.

Any new well located in the vicinity of Well 6 should be placed sufficiently far from it to exert minimal drawdown influences on it. To reduce this distance, pump rates at Well 6 could be reduced to allow a rise of water levels, yielding an increase in the available well drawdown. Finally, it may be appropriate to pump at somewhat reduced rates for longer durations during periods of high demand to

avoid excessive drawdown resulting from short periods of high pump rates.

The ground water resource in the area of Well 5 appears to be fully recharged. Unfortunately, contamination of this well casts some doubt on the acceptability of ground water supplies in this area for municipal use. Although the resource appears sufficient to support additional withdrawal, an evaluation into the nature and extent of the contamination would be prudent before new wells are located in this area.

The potential for ground water contamination may be widespread and relatively difficult to assess throughout the subject area without drilling and sampling candidate well sites. Even then, contamination can migrate as a result of localized changes in ground water flow due to well withdrawals. To minimize the potential for contamination of new wells, we believe an inventory of possible contamination sources in the candidate areas should be incorporated into well site assessments. Appropriate sanitary seal depth should be carefully evaluated prior to completion of new wells.

Prior to selecting a new well site, we believe conducting an adequate pump and/or recovery type test of City wells nearest to candidate well sites would be helpful to estimate aquifer characteristics important in determining appropriate well spacing, pump rates, and expectable drawdowns. In either a pump or recovery type test, construction of an observation well is recommended to augment the pumping/recovery well data.

In addition to well tests, an inventory of the existing wells in the vicinity of proposed well sites should be conducted to collect pertinent data such as water levels, rates of discharge, and well depths. This data could provide useful information regarding the condition of the ground water resource in the well vicinity and in identifying nearby wells subject to possible interference from additional ground water withdrawals.

New wells should be carefully logged by a geologist during well drilling, and by down-hole geophysics after drilling has been completed. In addition to electric logs, the geophysical logging program should include a gamma log to assist with identifying clay strata. Selective sampling during drilling can provide grain-size information to provide a basis for selecting an appropriate well screen and filter pack. Chemical testing should be done to determine if the quality of the water is acceptable for municipal uses. To estimate the sustained yield of a new well, a pump test should be

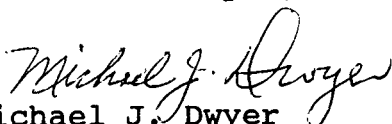
performed upon completion of the well(s). These tests should be performed sufficiently long enough to estimate appropriate long term pump rates.

A careful water level monitoring program of the existing City wells is essential in evaluating aquifer conditions and managing the well field. Water levels obtained immediately prior to pumping and near the end of the pump period could provide approximate maximum and minimum water levels. Accurate pump discharge rates and duration of pumping should also be recorded and considered in conjunction with water level data.

CLOSURE

We trust this report contains the information on ground water availability you require at this time. Please note, the report provides our professional opinion, based on our scope of work, and the report is not intended to be a certification, guarantee or warranty. Should you have any questions, please contact us. Thank you for the opportunity to be of service.

Sincerely,
Michael J. Dwyer, Inc.


Michael J. Dwyer
CEG 782

8 copies submitted

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